

A New Clinical Sphygmograph.

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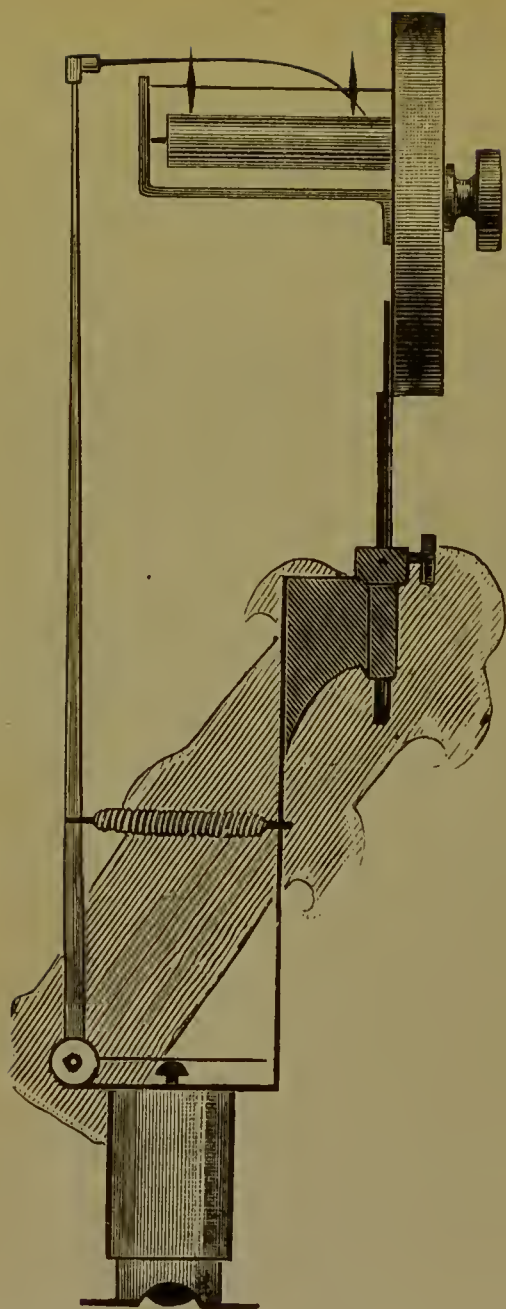
A NEW CLINICAL SPHYGMOGRAPH.

The defects of the different forms of sphygmograph in use are so well known to those who have worked with that fascinating, but capricious instrument, that I will not formally set them forth, but advert to them in connection with the description of the devices employed to avoid or minimise them.

This sphygmograph consists in a base composed of a piece of metal tubing with a broadened foot, sliding within another, and supported by a pretty stiff spiral spring. This slide and spring are intended only for the support of the instrument and regulation of the pressure, but in no way for *measuring* the pressure. Within this base moves the pad or plunger with a stem. The top of the stem bears against the arm of a bent lever, the long or writing arm of which is made of wood for the sake of lightness, and which carries on its summit the writing needle. The smoked paper is carried horizontally under the needle and receives the trace.

Pressure is made by a fine spiral spring attached to the long arm of the lever.

Some of these points will be better understood by reference to the well-known sphygmograph of Pond, which has been so largely used in this country and commended abroad, and which is undoubtedly for clinical purposes (when applied without the arm rest) much the most convenient



(unless Dudgeon's, which I have not used, be an exception).

This instrument resembles Pond's in the sliding base, the upright lever, and the horizontal paper. It differs in the omission of the India rubber membrane which has so many defects to counter-balance its one merit of convenience. It deteriorates and loses the essential property of a spring, elasticity; when renewed it can never be adjusted twice alike; and most important of all, it carries a certain, or rather uncertain, proportion of the pressure made by the wide base upon the neighboring tissues over to the pad, so that the graduations on the sliding stem can never represent the pressure on the artery alone, but on the neighborhood, and especially on the radius and the tendon of the flexor carpi radialis. These criticisms may not apply to the other form of base used with the Pond.

FROM THE SAME PULSE.

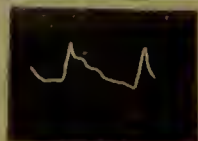
Marey.

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Pond.

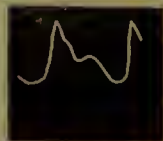
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As taken by new Sphygmograph.



Same, magnified vertically and reversed.



The lever in this instrument is but one, and there is no arrangement by screw or otherwise for adjustment of the pad to the writing levers to suit different degrees of the pressure.

As a result of this we have one apparent disadvantage and several real advantages. The latter are: First, that the position of the tracing upon the paper is itself an indication and record of the pressure upon the artery, so long as the spring remains the same. Any given pressure exerted upon the pad will always draw the needle to the same place. The pressure may be varied while the paper is in motion, and its effect on the tracing thus becomes evident; or what takes but little more time, and is more elegant, several tracings at different pressures may be taken on the same slip. This implies, as one familiar with the instrument will at once notice, a much diminished amplitude of motion in the writing point. The tracings do not to the naked eye present the ordinary appearance, but look like the very feeblest to be taken with any of the other forms. Second, the diminished motion of the lever removes one source of error which has always been recognized, and which has been partly avoided in Marey's by connecting the two levers, but which remains in Pond's owing to the weight of the upper lever and counterpoise. It has even been exaggerated in a very sensitive and beautiful instrument made under the direction of Dr. Hopkins, of Buffalo. This source of error is the acquired velocity of the moving parts, which may carry the point beyond the level to which it comes by the action of the artery, thus making the elevations higher and the depressions lower than they should be. I cannot see why this instrument, leaving out the error of friction, should not give an absolutely faithful transcript of the

curve which is described by the surface of the artery.

Errors due to looseness of joints are also avoided.

The want of distinctness in the tracings would, however, be far more than an offset to all these advantages; would, in fact, make the instrument almost worthless, if it were not for a device never before introduced into sphygmography. It is not original with me, but depends upon a suggestion from my ingenious friend, Dr. William P. Bolles, of Boston. It is the use of a cylindrical lens for reading the sphygmograms. This multiplies the amplitude of the tracings in the vertical direction about three times (or a stronger one might be used which would give four or five). The tracings which had before had so little variation in level as to seem meaningless, at once assume the appearance which will be recognized at once as corresponding more or less nearly to the common form.

The lens I have employed is composed of two of the strongest plano-convex cylindrical glasses, having together a focal length of 5 cm. They were procured for me square, that is before being mounted in the round frames in which they are supplied to test glass cases, by my friend, Dr. Swan M. Burnett, and mounted with the plain surface in apposition.

With the arrangements as now made which could obviously be varied considerably, the lever (short arm .9, long arm 10.2), amplifies about 11 times and the glass three or more, according to its position, thus giving 33 in the whole, or about that of Pond.

$$\frac{\text{Product of long arms}}{\text{Product of short arms}} = \frac{40 \times 30}{4 \times 9} = 33.3.$$

With the strength of spring used the pressure needed to start the writing, or to make the needle write near the lower edge of the paper is 30

grams ; near the upper edge 90 ; and in the middle 50 to 75. This range seems to be sufficient for ordinary pulses, but it will probably not cover the whole range required for exceptional cases. It certainly will not admit the high range spoken of by Marey and Burdon-Sanderson, but on the other hand, Brondel says it is very rare that pressures of 80 and 155 are required. It would not be difficult to have a second spring to be used in exceptional cases, or even for the higher range of pressures, so that the tracings might be written on two scales, like the two staves for music, instead of on an entirely indeterminate one as at present with the adjustable instruments. The higher scale may also be obtained by shifting the spine to a higher position on the lever.

The manner of holding and applying an instrument I believe to be of no little consequence. It is the ease of management and little trouble of the Pond, when used without the rest, which have made it so deservedly popular. The pads and straps of some of the others are sufficient to prevent their being freely employed, and thus acquiring a real clinical value, and I knew of an instance where the use of the Pond was nearly abandoned in a hospital, because it could not be made to work with the arm rest. I believe the almost trivial device employed with this instrument makes this even more convenient than the Pond.

This is a slip of metal connecting the base with the upright that carries the clock-work, and acting as a brace, which is so curved, and supplied with side pieces as to fit on the fore finger. The instrument is thus carried on one finger, while the middle finger can feel the artery if desired. While the instrument is applied, the thumb can

stop and start the clock-work, and the left hand is free to introduce and receive the paper; or be itself the object of examination.

I submit a number of tracings which may be examined with two or three of the highest cylindrical lenses to be found in the test case of the ophthalmologists. They are not intended to illustrate types of disease, but simply to show the working of the instrument. It will be noticed that they read in the opposite to the usual direction. This is because the clock-work of a Pond's sphygmograph, made to work with a different arrangement of levers, was used. If a new piece of clock-work were made it would, of course, be arranged to run in the usual direction.

